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THE EVOLUTION OF THE CHIN

BY DR. LOUIS ROBINSON

IN the acquirement of articulate speech man took an enormous stride upward from his brutish ancestry. Not even the adoption of the erect attitude nor the development of his versatile manufacturing hands helped his upward progress in anything like such a marked degree. Yet in attaining this power which at once put him on a higher plane of existence it must be remembered that he acquired not one single new organ or structure in his body. All had to be accomplished somehow with such bones, nerves, and muscles as his animal ancestors had passed on to him. This seems very wonderful when we come to reckon up the astonishingly elaborate physiological processes involved in articulate speech. The actions of very numerous muscles in the respiratory apparatus, the larynx, the tongue, and the lips, have been taught to work together in a way that had never been attempted before.

Perhaps the most marvelous thing of all about the functions of the organs of speech is that they are *brand-new* from an evolutionary standpoint, and are the product of one brief stage in our racial history.

In this they differ from almost all the other functions of the body, which date back through a long line of ancestry to the very beginnings of life on the earth.

The difference between human articulate speech and what takes its place in some measure among the creatures below us in the animal scale is enormous. Many creatures, the birds especially, have elaborate methods of vocal communication, and in all probability our prehuman ancestors possessed the same natural gifts; but the difference between any system of stereotyped animal noises and true human speech is so great that it seems doubtful whether the one is derived from the other at all. Probably in our modern methods of

expression we have a few fossil remnants of the old pre-human cries in the form of exclamations such as oh! and ah! which appear to be merely conventionalized groans or shrieks common to all the peoples of the earth, but scarcely any seem to have passed into our accepted vocabularies.

Now in the adoption of human speech, and in the transformation of various pieces of animal mechanism for this purpose, structural differences must have arisen which should be quite easy to point out; just as the acquirement of the erect attitude has given rise to obvious changes in the spine and pelvis. These peculiarities of structure due to a radical change of habit seem to have attracted little attention, as such, from the anatomists, who are still to a great extent under the spell of the old view that man appeared suddenly in the world with all his distinctively human attributes. Yet ever since Darwin first taught us the truth, plenty of evidence has come to light that we have become both mentally and physically what we are through a series of evolutionary changes from some form closely resembling the great apes.

In the numerous comparisons between our bodily structure and that of the other Primates to which the evolutionary theory of man's origin has given rise, the anatomical parts of the tongue and lower jaw seem to have been curiously neglected; yet a very little study of these parts shows us certain curious and suggestive points of dissimilarity which at once invite further investigation.

When we examine the lower jaw-bone of a civilized man we find that the inner surface, corresponding to the part between the lower incisor teeth and the chin, is convex from above downward, and has on it certain bony prominences or tubercles. In every current work on anatomy this is set forth as the normal condition of affairs, and certainly it is true of the higher races. Among all the apes, without exception, an exactly opposite condition is found. Here the inner surface of the jaw-bone tends to be concave in profile, and where in man there is a marked bony prominence, or tubercle, we find a pit or depression, sometimes so deep that it almost penetrates through to the front lamina of the bone.

I do not know whether any comparative anatomist has previously made out the purpose of this curious pit in the jaws of the apes: I certainly was not aware of it myself until a series of dissections showed that from the bottom of

the pit arose the tendon of a muscle called the *genio-glossus*, which spreads out like a fan along the middle line of the lower surface of the tongue and obviously assists greatly in its movements. Then it became plain that the pit served the special purpose of giving room for this little muscle, which is evidently of importance in the economy of all the lower Primates.

An examination of the jaw-bones of other animals such as dogs, cats, pigs, etc., shows no trace of this pit, and in most of them it is obvious that the tongue lies flat in the lower jaw-bone, with no room between for the working of any muscular machinery which could pull in a direction at right angles to the main plane of the tongue. Now the special purpose served by the *genio-glossus* muscle in monkeys is in all probability that of aiding the tongue to act as a sorter of the contents of the mouth, so that undesirable refuse such as nutshells, for example, should not be swallowed. Many of the Old World apes also warehouse a good deal of miscellaneous provender in their cheek pouches, and here the tongue plays the part of storekeeper, dealing out what is required of the stock in hand. Most other animals, such as dogs, seem to show great difficulty in getting rid of any undesirable morsel which has once been taken into the mouth, and when it is necessary to do so quite other processes are made use of. An examination of the interior of the mouths of our domestic cattle, or, better still, of camels and giraffes, shows that the cheeks are lined with a great number of long, pointed papillæ, and the animals manage to get rid of dangerous thorns or other undesirable objects by pushing them sideways and then moving the tongue backward and forward so that the papillæ take charge of them and work them out.

It is worth while to take careful note of this discriminating function of the tongue of the apes in which the *genio-glossus* muscle seems to play a great part, because it appears to be the basis or rough material from which our most important lingual speech machinery has been evolved.

It is, of course, obvious that the remarkable difference existing between the jaws of the apes (which almost certainly correspond with those of our prehuman ancestors) and the modern type of human jaw was the result of no sudden change.

The writer has been able to demonstrate the whole prog-

ress of this interesting piece of evolution, and also to point out the still more interesting reasons why it occurred. Some years ago when his attention was first drawn to the remarkable difference in the inferior maxilla of apes and of men, he commenced making a series of plaster casts of the parts involved for purposes of exact comparison. This was done because, even in the most complete museums, it is difficult to get a large number of mandibles side by side and carefully to examine their differences. His method was to carry about with him some pieces of wax that would soften at a low temperature and, whenever opportunities offered, to take impressions of that part of the inner side of the lower jaw which is beneath the incisor teeth. The whole family of the Primates was brought into requisition as much as possible from the lemurs to modern man, and a large collection of plaster facsimiles of jaws was so obtained. Fortunately the natural-history museums of Europe, and especially of England, afford an abundant supply of material. Most useful of all was the remarkable ethnological collection in the museum of the Royal College of Surgeons, in London, which has been contributed to by numerous explorers, colonists, and missionaries from all parts of the world. A description of the whole series thus obtained would be a wearisome business to those not interested in anatomical minutiae. Let it suffice to say that from the mass could be selected a number which showed a gradation without a single break from one extreme type to the other; that is, from the concave surface and deep pit of the lower monkeys to the convexity and pronounced tubercles of modern man.

It is the change in the general outline of the jaw in man which is the most remarkable from the anatomist's standpoint, since it involves a departure from the type that is almost universal among all vertebrates. There is a strong tendency observable throughout Nature to follow certain beaten tracks, and whenever we find a marked deviation taking place it is a pretty sure sign of special evolutionary forces conducing to the change. Naturally each creature tends to inherit the general structural features of its parents; hence where no circumstances of environment enforcing a change come into play there is a remarkable conservatism manifest throughout Nature. Conversely, if we find that one part of the body has in a comparatively few

generations undergone a complete change of shape we may be sure that it signifies some urgent adaptation to new conditions of life.

Now the shape of the lower jaw has been curiously uniform from the earliest mesozoic times, except where certain special changes have been caused by the needs of such animals as the whale, the elephant, and the dugong. Hence when we find the ordinary retreating surface of the lower jaw-bone tilted downward so as to form a human chin, we may be sure that such a change was absolutely necessary in meeting certain needs. Those students of mankind who have not, like the older type, taken the human face for granted as the product of a single creation, have endeavored to account for man's chin by saying that it is essential to the human ideal of beauty. This really does not help the solution at all, unless we know how such an ideal arose. Doubtless in every species of animal the ideal differs, otherwise we should not find the many peculiar forms of decoration which evidently, in their proper place, appeal to the admiration of the other sex. This would be doubtless true of monkeys and of man's apelike ancestor, as it is of birds and other highly decorated creatures where sexual selection evidently has such a marked influence. But if at one time an apish ideal satisfied our early forefathers, and a very different ideal appeals to us, it is evident that we have to account for the change of standard.

Now there can be no doubt that sexual selection has been a great aid to progress, because the traits which appear worthy of admiration are very often an index to higher qualities of mind and body. There appears to be an instinctive perception of the trend of things toward a higher plane, since practically every characteristic which tends to satisfy our ideal of human beauty is an index of those qualities which conduce to the prosperity of the race. If any physical change is called for to bring some animal into harmony with its environment, those creatures which vary in this direction would be more successful in life's race, and therefore more desirable as mates or comrades.

Hence if the human chin was a distinct index of qualities leading to success among human affairs we may be sure that it would become a desirable feature, and a thing of beauty, in the eyes of our remote progenitors when matrimonially inclined.

Why was the lower edge of the front of the mandible tilted further and further downward as man advanced to his distinctly human status? That such was the fact is shown by those interesting relics which have recently come to light, found near Heidelberg, and at Piltdown in Sussex.

The fact is that, when the *genio-glossus* muscle, so useful among the apes in aiding the tongue in sorting shells from kernels, was required for the much more exacting processes of human speech, the arrangement to give it room to work beneath the tongue had to undergo a total alteration. In anything like rapid articulate speech the tongue performs from eight to ten separate movements per second. Absolute precision is required, otherwise articulation becomes imperfect; and hence there is a need of machinery which works unhampered, and at the greatest possible mechanical advantage. Now in the human subject the *genio-glossus* muscle is very different from that in any of the apes. Not only is it much larger, but its wider form enables it to spread up into a number of separate bundles which act independently of one another just as if they were so many distinct muscles. One interesting proof of this is the way in which it receives its nerve supply, for the *hypo-glossal* nerve (in man), instead of entering it at one spot and splitting up within the muscle, after the usual manner of muscle innervation, splits up before reaching the *genio-glossus* and sends a separate branch to each fasciculus.

In the human subject the muscle is not only much larger than in any of the apes, but its importance among the tongue muscles is also greatly increased. Here is proof that the functions that it performs have to do with our distinctively human existence. Curiously enough, the anatomists seem to have ignored this fact altogether, and scarcely any of them make any allusion whatever to the *genio-glossus* as having duties in aiding articulate speech. The functions allotted to it in our books of anatomy are those of thrusting out and drawing in the tongue, and of lowering its central region as in the act of sucking. It is, of course, obvious that there are plenty of animals which do all these things as well, or better, than human beings; and yet in some of them the muscle is a barely perceptible slip of flesh.

Any one with a diagram of the muscle before him can convince himself as to its peculiar action in the pronouncing of such sounds as the letters **T** and **K**, in which certain

parts of the tongue have to be drawn away from the roof of the mouth with great precision and rapidity. In such cases the pull of certain fasciculi of the *genio-glossus* is, at the moment of action, practically at right-angles to the main plane of the tongue, and a mere shortening of the fibers concerned accomplishes the act in the simplest possible manner.

Now in order to get this free and independent action the separate bundles need to spread well away from their fellows from their very point of origin on the inner side of the lower jaw. When the fibers are crowded in a deep pit, as in the monkeys, it is obvious that there can be no such independent action: hence the tilting downward and forward of the lower edge of the jaw to give engine room beneath the tongue for the free working of this needful piece of machinery. Nature even goes further than this in facilitating the above arrangements, for in all the more highly developed races of mankind a little prominence appears just below the site of the ancient pit. From the summit of this the radiating fibers of the muscle can obviously spread with the greatest advantage, and no risk remains of their hampering one another.

The muscles of the tongue are of two distinct kinds. The organ is mainly made up of fleshy fibers which commence and end in the tongue itself. Broadly speaking, these consist of a longitudinal layer of fibers on the upper surface, a transverse layer through the middle, and another thin longitudinal layer underneath. These muscles may be compared to those toward the tip of an elephant's trunk. Obviously in all their movements they must be associated together, and hence are too much hampered for very rapid and precise action. Doubtless these intrinsic muscles of the tongue play a considerable part in speech, but were it not for the control obviously exercised over them by the extrinsic muscles (which are attached to firm bony points) they could not be of any great service. In the pronunciation of the letters given above it is probable the superior lingual is responsible for bringing parts of the tongue to the roof of the mouth. The limitation of this action, however, and especially the rapid movement away from the palate, must be due to some part of the fanlike *genio-glossus*.

Since nearly all the movements connected with articulate speech take place along or near the central line of the tongue, we need pay but little attention to the other ex-

trinsic muscles reaching it from bony points outside, such as the hyo-glossus and stylo-glossus. In apes and in some lower animals which I have dissected these appear almost as well developed as in man, whereas the genio-glossus is not found anything like so fully developed in any other creature. One chief duty of the genio-glossus appears to be to act as a *control* in exactly regulating the position of the upper surface of the tongue as regards the palate. In diagrams illustrating the position of the tongue and palate in the pronunciation of different vowels Professor von Meyer of Zurich has shown the importance of this adjustment. Strangely enough, however, it seems never to have occurred to him that the genio-glossus muscle was the only agent capable of exercising this exact control all along the upper surface of the tongue.

As I have said above, the plaster casts which I have collected show a complete gradation in the arrangements for the play of the genio-glossus muscle from the deep pit present in all the apes (which I have called the simian pit) to the prominence known as the genial tubercle in our current works on human anatomy. Of this series of specimens the first is a fossil lemur in which the ancient generalized type of jaw is beginning to manifest certain apelike characteristics. Here two small depressions are visible which are the commencement of the simian pits. As soon as we reach the monkeys, especially the catarrhine apes of the Old World, we find that the pit has become very much deeper. In the baboons, the outward shape of whose heads shows considerable resemblance to those of bears or dogs, we find an exceedingly deep hollow in the under jaw. No observer could possibly mistake the mandible of a baboon for that of one of the carnivora, in which class of animals any such provision for the genio-glossus muscle is quite wanting.

When we reach the anthropoid apes the type is beginning to change, for in some oranges and chimpanzees, and especially in certain of the gibbons, the lower edge of the jaw-bone beneath the incisor teeth is tilted somewhat downward. Whenever this occurs it eases the crowding of the structures beneath the tongue, so that the pit is no longer necessary, and tends to become shallower. In my series of specimens of apes' jaw-bones, the one with the least depression of all is that of the siamang gibbon, which has quite a respectable chin. Next in the series come the two very ancient human

jaw-bones found at Heidelberg and at Naulette, both of which show the simian pit still present in almost as marked a degree as in the siamang.

It may be as well to remark here that in the celebrated Heidelberg jaw there is a tubercle present which has been mistaken for the place of attachment of the genio-glossus muscle. A comparison with other jaws, however, at once shows that it is too near the lower border to answer this purpose, and that it represents one of the lower and lesser genial tubercles described in our books on human anatomy. These give attachment to a muscle which passes straight from the lower jaw to the hyoid bone, and has no connection with the tongue. This muscle, with its bony point of attachment, is well developed among the apes in other lower animals.

Next in the scale is a Central African Pygmy, in which the pit is as deep, or deeper, than in prehistoric man. Then come a series of very remarkable specimens consisting of all the Bushmen and Hottentot jaws that I have been able to obtain. They offer considerable variety, but all are very different from the civilized type. In the great majority no tubercles have arisen and the remains of the pit are present. In some the surface is almost smooth, and in others—especially in the Hottentot jaws—two tiny prominences are seen beginning to bulge up from the concave under side of the pit. Next above the Bushmen and Hottentots come the Andamanese, who are somewhat akin to them in race, and the Veddahs of Ceylon. These all differ very markedly from the type described in our current works of anatomy.

As soon, however, as one examines jaw-bones from the higher grades of savages one gets an approximation to the civilized type, and this approximation increases as one goes up the scale of civilization.

It is, of course, too much to say that any part of the mechanism apparent in the structure of modern men which has to do with articulate speech is absolutely necessary to enable people to talk. We know quite well that many of the savage languages consist largely of guttural noises, clicks, and other uncouth sounds in which very few elaborate tongue movements would be required, and yet such people make themselves sufficiently understood as far as their needs go. It is, however, a noteworthy and suggestive fact that in various parts of the world where elaborate languages have

been evolved independently, and now play an important part in the lives of the people, all the speech mechanism which we have been here discussing is shown in a highly developed form.

I think it is exceedingly probable that most characteristics of the human countenance in which it differs from the same parts in apes and other animals bear traces of the influence of articulate speech. For instance, the air-chambers of the nasal passages, brow, and cheek bones have an undoubted value in increasing the resonance and in improving the quality of the voice. This is proved by the fact that, when these chambers are blocked by catarrh or inflammation, the effect on the voice is disastrous. Let any one, while declaiming some impressive piece of oratory, try to continue it with the nostrils held, and the whole performance degenerates into a ludicrous farce. Now our prominent noses and the filling out of the cheek-bones beneath the eyes to give room for that large chamber called the *antrum of Highmore*, together with the heightening of the brow above and the lessening of the alveolar part of the jaw to accommodate our smaller set of teeth, account for the main differences between "the human face divine" and the animal visage of any of the apes. It would take one too far afield on the present occasion to discuss the relationship between articulate speech and these other parts of the face—so let us return to the lower jaw.

In most anatomical museums, and at many colleges where scientific dentistry is taught, are to be seen preparations of human and animal jaws with the outer wall taken away to show the growth of the teeth in the alveolar cavities. An examination of such a preparation of the jaws of one of the great anthropoid apes is exceedingly instructive. The enormous lower canines have their roots reaching down almost to the lower border of the mandible, which is evidently enlarged for the purpose. Moreover, these roots are in sockets in the bone supported by stout buttresses which approach one another on each side of the chin.

Here, I take it, we find the raw material out of which our chins have been built. Man long ago lost his great canine teeth, and it has been said that no human jaw shows any evidence of his having possessed them; yet every human mandible still appears to retain the abundant bony tissue which was developed for their support.

A survey of the functions of the inferior maxilla throughout the mammalia shows that it serves the purpose simply and solely of a holder of the lower teeth, and that any bony tissue that does not aid in this purpose is scarcely ever found. Now it is a curious and suggestive fact that the bony mass which formed the buttresses for the sockets of the lower canines of a pre-human existence has not degenerated since man lost these primitive weapons, but has rather become more developed. Here it is instructive to consider the case of the elephant, who possesses a kind of pseudo chin. When we study its evolutionary history we find that this bony prominence on the elephant's lower jaw is merely a degenerate scrap left behind by the huge projecting mandibles of the elephant's ancestors the *Tetralodon* and the *Paleo-Mastodon*. As soon as the projecting lower teeth of these ancient beasts went out of fashion the bony support rapidly shrank away, so that we find it in progressive stages of degeneration in the true mastodon and the modern elephant.

In man, on the contrary, the chin seems to project more and more as he progresses toward his modern civilized condition. This must imply that, immediately the huge lower canines degenerated, the part took on some other function of vital importance to the race, and that the need has increased with his intellectual and social advancement.

My theory, then, is that the chin is essentially a part of the mechanism of articulate speech.

It is tempting to theorize a little further and to suggest that the human chin perhaps bears testimony to a prehistoric change from carnal weapons to others, which, if not exactly spiritual, were such as appealed to the part of us where spiritual forces work; for apparently long ago before the pen proved mightier than the sword the tongue proved mightier than the teeth.

If one could only prove this one might show that, even before the Glacial Epoch, Parliamentary institutions (using the term in its widest sense) began to take the place of lethal weapons in settling disagreements; and that the substitution of Arbitration for War is not merely a doctrine of latter-day moralists, but is a part of the ordered march of Cosmic progress, as inevitable as the other evolutionary changes which have brought us up from among the brutes.

LOUIS ROBINSON.